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ANOTHER STRAIN OF PUCCINIA GRAMINIS

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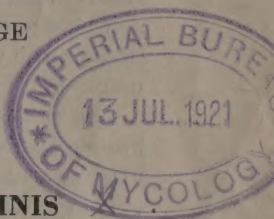
As a part of the cereal rust investigations carried on at the Kansas Agricultural Experiment Station, in coöperation with the Office of Cereal Investigations of the United States Department of Agriculture, the writers have been studying the rust resistance of wheat varieties. In conducting the greenhouse work during the fall of 1917, a strain of stem rust of wheat was used which had been collected in the field at St. Paul, Minn., and which at the time was supposed to be the usual *Puccinia graminis tritici*.

The behavior of this rust on the three varieties of hard red winter wheat (Kanred, P 1066, and P 1068), which the writers have found to be remarkably resistant to *Puccinia graminis tritici*,¹ gave evidence that this strain of stem rust was quite different from those previously used.

The resistance of these winter wheat varieties to *Puccinia graminis tritici* first noted during the summer of 1916 in the rust nursery at the Kansas station, was again noted in 1917. Greenhouse tests carried on during the winter of 1916-17 fully confirmed the field observations. The seedling leaves of these three wheat varieties when inoculated with *Puccinia graminis tritici* did not produce any normal uredinia; in fact, the flecks or visible hypersensitive areas usually present in resistant varieties were seldom observed.

When the first series of seedlings was inoculated with this new form of stem rust, very severe and quite normal infections resulted on 100 per cent of the leaves. The uredinia appeared after the usual incubation period and were numerous, large, and as vigorous as those on any susceptible wheat. These tests were repeated, using seed from the same packets used in the greenhouse

¹ Three varieties of hard winter wheat resistant to stem rust. Leo E. Melchers and John H. Parker. Abstract in Phytopathology 8:79, February, 1918.



work of the previous winter and also from resistant plants (individual selections) from the rust nursery in 1917. In all of the tests, which included more than 1,000 seedlings, the infections on Kanred, P 1066, and P 1068 were very severe. The uredinia resembled in every way those on the seedlings of Iowa Red Winter (P 706), the variety used as a check in all of the inoculation experiments and known to be very susceptible to *Puccinia graminis tritici*.

As an additional check on the results of the previous year, a known culture of *Puccinia graminis tritici* was secured through the kindness of Mr. M. N. Levine of the Minnesota Agricultural Experiment Station. Inoculations made with this rust on seedlings of Kanred, P 1066, and P 1068 did not result in the production of any normal uredinia, but fully re-confirmed the results of the previous two years. Therefore, the conclusions as to the resistance of these three wheat varieties to *Puccinia graminis tritici* remain the same.

In February, 1918, a similar, if not an identical, strain of wheat stem rust was collected in Kansas by Dr. Charles Drechsler. Its infection capabilities, so far as tested, are similar to those of the form collected at St. Paul, Minn. The morphological characters of the urediniospores, so far as examined, are also similar, and therefore, in referring to the two strains in this preliminary report, they are considered as being the same.

The experimental results which prove this new form of stem rust to be a physiological race, distinct from *Puccinia graminis tritici* have already been given. According to Stakman and Piemeisel,¹ plants of the variety Haynes Bluestem (Minnesota No. 169) are not congenial hosts for *Puccinia graminis tritici-compacti*, Stak. and Piem.² When inoculated with the strain of stem rust collected in Kansas, all the seedling plants of this variety were found to be completely susceptible and the uredinia were quite like those of *Puccinia graminis tritici* on the same variety of wheat.

No very extensive tests with this new rust form on other wheat varieties have been made, but the results so far obtained are of some interest in their relation to the general problem of rust resistance in wheat. Inoculations on seedlings of Iowa Red Winter (P 706) always resulted in the production of normal uredinia; this variety thus serves as a congenial host for both *Puccinia graminis tritici* and for the new form.

¹ Biologic forms of *Puccinia graminis* on cereals and grasses. E. C. Stakman and F. J. Piemeisel. Jour. Agr. Research 10:429-496. August 27, 1917.

² The occurrence of *Puccinia graminis tritici-compacti* in the Southern United States. E. C. Stakman and G. R. Hoerner. Phytopathology 8:141-149. April, 1918.

When seedlings of Kubanka (C. I. No. 2094) were inoculated, about the same degree of resistance was manifested which this variety shows toward *Puccinia graminis tritici*. On some of the leaves there were only very small light green or yellow flecks; on many leaves there were a few sub-normal uredinia; on others there were large uredinia which resembled those formed on susceptible varieties.

Inoculations on seedlings of White Spring Emmer (Minnesota No. 1165) and on Khapli Emmer (C. I. No. 4013), both of which are extremely resistant to *Puccinia graminis tritici*, gave results closely resembling those obtained with the latter strain of rust. On seedlings of White Spring Emmer (Minnesota No. 1165), minute uredinia were relatively rare; those of normal size were only occasionally produced, while often the only evidence of infection was the appearance of rather indistinct flecks. The inoculated seedlings of Khapli Emmer (C. I. No. 4013) showed only very small uredinia. These were generally present on all leaves inoculated, but were never as large or as vigorous as the uredinia on susceptible varieties. It is thus apparent that this new rust does not have an effect on these varieties very greatly different from that of *Puccinia graminis tritici*, i. e., their resistance is not "broken down" to the same extent as that of Kanred, P 1066, and P 1068. It is therefore possible that the basis of the resistance in these two groups of varieties is different. That is to say, the resistance of Kanred, P 1066, and P 1068 appears to be more sharply limited than that of the resistant varieties of emmer and of Kubanka (C. I. No. 2094). A more complete understanding of the causes of resistance in these and other varieties is necessary before the reason for these differences can be firmly established.

On the other hand, it may be true that these different relationships depend principally on the biologic specialization of the pathogens, rather than on the characters of the host plants.

It is obvious that the wheat stem rust problem in the United States is made more complex with the discovery or evolution of each new form, whether their geographic distribution proves to be due primarily to factors of environment or to certain characteristics of the host plants. Especially is it necessary to consider the problem of testing and breeding wheat varieties for rust resistance as a local one, not only in relation to particular rust species, but also to the several distinct biologic forms of one species. For example, it is now known that one of the wheats (Haynes Blue-stem), which is very susceptible to *Puccinia graminis tritici* in the upper Mississippi valley, is, under greenhouse conditions, sharply

resistant to *Puccinia graminis tritici-compacti*, a form which occurs in the Pacific Northwest and in certain of the Southern states. On the other hand, the three varieties of hard red winter wheat shown by the authors (*loc. cit.*) to be remarkably resistant to *Puccinia graminis tritici* are now found to be very susceptible to this new rust form, which has been collected in both the hard spring and hard winter wheat areas.

From microscopic examination and measurements of urediniospores so far made, it appears that this new form is morphologically distinct from both *Puccinia graminis tritici* and *Puccinia graminis tritici-compacti*. The majority of the urediniospores of this new form, so far examined, vary in shape from ellipsoidal to ovate, but some are sub-spherical, a condition not usually present in other forms of wheat stem rust. It is a well-known fact that the limits of variation of the urediniospores of *Puccinia graminis* in size and shape are rather wide. These morphological characters are largely dependent on the host plant and its nutrition, and on the age of the uredinium, as well as on other factors. A representative number of urediniospores from a wide range of hosts, grown under known conditions, must therefore be examined before final conclusions as to morphological characters can be drawn.

These sub-spherical urediniospores do not closely resemble those of the orange leaf rust of wheat, *Puccinia triticina*, in color, shape, or in position and number of germ pores.

Inasmuch as the *infecting* power of the new strain with reference to the three varieties of hard winter wheat which are so resistant to *Puccinia graminis tritici* is one of its outstanding characteristics, the name *Puccinia graminis tritici-inficiens* form. nov. is proposed.

It is planned to give further attention to the morphological characters of this new rust and to test more widely its infection capabilities and host relationships. The results of these studies as well as further details of the work already completed will appear in a subsequent paper.